Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

SHORTER ARTICLES AND DISCUSSION

LINKAGE IN MAIZE: THE *C* ALEURONE FACTOR AND WAXY ENDOSPERM[1]

In 1912 Collins[2] presented data which showed a linkage between waxy endosperm and aleurone color in certain hybrids of Chinese and American corn. A summary of the F_2 data in Table II, p. 579,[2] gives the coefficient of association as .821. This is equivalent, approximately, to a 3.5–1 gametic ratio, and a crossing-over percentage of 22. The percentage of waxy grains is about 21 and colorless about 25. This is good evidence that Collins is dealing with material heterozygous for waxy endosperm and heterozygous for only one factor in aleurone. In the back cross data in Collins's Table IV none of the ears shows the 1:1 relation between colored and colorless expected from plants heterozygous for one color factor. The material in that table apparently involves more than one aleurone factor in the heterozygous condition and before such data may be considered in any linkage study they must be corrected for this or the true values for the percentage of crossing over can not be ascertained. The coefficient of association need not be used if we are dealing with back cross data. If it seems desirable to use the coefficient of association with this sort of data new tables should be calculated from the gametic series $n:1:1:n$ corrected for the respective aleurone factor conditions.

The advantage of back cross data is obvious. Data of this nature obtained by the writer from crosses of plants heterozygous for one aleurone factor and for waxiness with double recessive plants are presented in the table on p. 58.

Families 6, 99, and 100 are derived from colored corneous seeds heterozygous for aleurone and waxiness. Families 9 and 101 are colorless waxy plants. The first nine ears give an average crossing over of 26.7 per cent. or a gametic ratio of 2.75:1. Ears 8 and 9 show repulsion instead of coupling, but this does not necessitate a separate summary for the crossover and non-crossover classes of the coupling and repulsion families. The deviations from the average are more than twice the probable error in ears 1, 3, 4, and 9, between one and two times in ears 5 and 7, and less than the probable error in ears 2, 6, and 8.

---

[1] Paper No. 66, Department of Plant Breeding, Cornell University, Ithaca, N. Y.

[2] "Gametic Coupling as a Cause of Correlations," Amer. Nat., 46, pp. 569–590. 1912.

Back Cross Data: Heterozygous Corneous Colored × Waxy Colorless

Ear Number	Parentage	Corneous Colored	Corneous Colorless	Waxy Colored	Waxy Colorless	Non Cross-overs to Cross-overs	Per Cent. of Crossing Over	Deviation from 26.7 Per Cent.	Probable Error in Per Cent.	Dev./P.D.	Per Cent. Waxy	Per Cent. Colorless
1	100(6)×101(1)	147	58	65	133	280:123	30.5	3.8	1.49	2.55	49.1	47.4
2	100(1)×101(3)	104	24	32	67	171: 56	24.7	2.0	1.98	1.01	43.6	40.1
3	101(9)×100(9)	102	60	43	137	239:103	30.1	3.4	1.61	2.11	52.6	57.6
4	100(5)×101(4)	170	49	39	136	306: 88	22.3	4.4	1.50	2.93	44.4	47.0
5	101(3)×100(8)	124	53	60	153	277:113	29.0	2.3	1.51	1.52	54.6	52.8
6	101(5)×100(6)	71	24	9	31	102: 33	24.4	2.3	2.57	.89	29.6	40.7
7	100(11)×101(4)	140	42	63	124	264:105	28.5	1.8	1.55	1.16	50.7	45.0
8	101 (2)× 99(1)	46	111	103	32	214: 78	26.7	0	1.75	.00	46.2	49.0
9	99 (1)×101(9)	69	229	195	60	424:129	23.3	3.4	1.27	2.68	46.1	52.3
	Total					2,277:828	26.7		0.54		47.7	48.4
	6 (6)× 9(6)	118	114	128	131	249:242	49.3	22.6	1.35	16.74	52.7	49.9

Owing, perhaps, to the difficulty in separating waxy from corneous grains the percentage of waxy grains for the total of the 9 ears is only 47.7 ± .6. The deviation from the expected 50 per cent. is nearly four times the probable error, indicating a poor fit. The percentage of colorless grains is 48.4 and the deviation is two and two thirds times the probable error. Here the separation is accomplished with a somewhat greater degree of accuracy. On the whole, the data seem to show conclusively that we are dealing with a linkage between waxy endosperm and one of the aleurone factors.

Ear No. 10, which is derived from a non-linkage family and included in the table for comparison with the first nine ears, is also the result of a back cross. The per cent. of crossing over is 49.3, which is practically equivalent to independent inheritance. The deviation from 26.7 per cent. of crossing over is 16.74 times the probable error and the odds against this being due to random sampling are enormous.

EVIDENCE THAT THE *C* FACTOR FOR ALEURONE COLOR IS CONCERNED

Although the linkage data are interesting and valuable, it is perhaps of greater interest and value in the study of maize inheritance to know which of the aleurone factors is concerned in this linkage. This may be determined, where the inhibitory factor *I* is not concerned, by crossing plants grown from either colorless waxy or colorless corneous grains taken from families showing linkage with plants that are homozygous recessive in turn for one of the aleurone factors and homozygous dominant for the remaining factors. Plants of this nature were available in Professor Emerson's aleurone testers.

At least five factors are now known to be concerned with development of aleurone color. They are known as the *A, C, R, Pr* and *I* factors. *A, C* and *R* are necessary for the development of red. The dominant *Pr* factor changes red to purple. That the *Pr* factor is not concerned in this linkage is evident from the fact that the linkage relation is observed in segregations of colored and non-colored aleurone and waxy and corneous endosperm regardless of whether they are purple or red, and from the fact that only red aleurone seeds were used in obtaining the back cross data which show the linkage. That the inhibitor is not involved is inferred from the fact that the segregation on the original parent ear was 195 corneous colored, 95 corneous colorless, 95 waxy colored and 15 waxy colorless which is approximately a 3:1 segregation of colored to colorless aleurone. The relation of the *A, C* and *R* factors to waxy endosperm remains to be accounted for. This may be determined as stated above by the use of aleurone testers, which are named for the pair of factors which is homozygous recessive. The following diagram explains the method of testing for these factors.

Constitution of Aleurone Testers	The Constitution of Colorless Grains from the 3 : 1 Ear may be		
	aaCCRR	*AAccRR*	*AACCrr*
A tester, *aaCCRR*	No color	Color	Color
C tester, *AAccRR*	Color	No color	Color
R tester, *AACCrr*	Color	Color	No color

If the *C* factor were linked with the factor for waxy endosperm no color should appear in the F_1 from a cross between the *C* *R* and *A* testers colored ears should be obtained. Crosses of this nature were made in 1916 and 1917 with the following results:

Colorless Aleurone with *C* Tester

Year	Parentage	Approximate Number of Seeds	Color of Aleurone
1916.....	1 (2) × 6857 (9)	360	No color
1916.....	2 (14) × 6857 (12)	240	" "
1916.....	2 (9) × 6857 (4)	500	" "
1917.....	101 (1) × 7506 (2)	250	" "

Colorless Aleurone with *R* Tester

1916.....	1 (5) × 6867 (19)	480	Colored
1916.....	2 (1) × 6868 (6)	200	"

Colorless Aleurone with *A* Tester

1917.....	101 (7) × 7505 (2)	150	Colored

The above data are believed to show conclusively that the *C* factor for aleurone is linked with the factor for waxy endosperm, because the *R* and *A* testers caused the development of aleurone color when crossed with colorless individuals from the same family while the *C* tester did not.

Non-Linkage of Aleurone Color and Waxy Endosperm

It is interesting to know that in ear 10, which shows no linkage, the *C* factor for aleurone was not heterozygous. A colorless waxy individual from this family crossed with the *C* tester produced an ear consisting of approximately 300 seeds, all of which showed colored aleurone.

Another waxy colorless individual of the same family crossed with the *R* tester produced an ear with 25 seeds, all of which were colored. Thus the *C* and *R* factors are eliminated with some degree of assurance. The *A* factor apparently is heterozygous in this family, but unfortunately the writer has obtained no crosses with the *A* tester to verify the conclusion reached by the process of elimination. This may be considered as indirect proof of the *C* factor as the aleurone factor which is linked with the waxy endosperm factor.

Summary

(*a*) Collins has presented conclusive evidence of the linkage between waxy endosperm and aleurone color. The writer has presented additional evidence from back crosses, which shows the intensity of the linkage in the material at his disposal to be equivalent to 26.7 per cent. of crossing over.

(*b*) It has been shown directly, by means of crosses between colorless individuals in a linkage family and aleurone testers and indirectly by means of aleurone tests with a non-linkage family where the *A* factor and not the *C* factor is heterozygous, that the *C* factor for aleurone is linked with the factor for waxy endosperm.

T. Bregger

Cornell University

INHERITANCE IN ORTHOPTERA

In a recent paper (Nabours, '17) Nabours has continued his admirable studies of inheritance in *Paratettix*. The paper is backed up with an abundance of data, from which a number of facts are deduced. In his discussion, he attacks certain modern hypotheses, and since it appears to me that his strictures are not entirely justified, I venture here to review the evidence, and make certain comments on it.

The following facts, several of which were well brought out in a previous paper (Nabours, '14), are presented:

1. A large number of distinct, true-breeding forms of *Paratettix* occur "in nature." Of these he has collected at least fourteen or fifteen. He no longer looks upon each as a distinct species, and he has dropped the "specific names" he suggested for them in the previous paper.
2. The distinguishing characteristics of these forms fall into two groups in their mode of inheritance: (*a*) Fourteen color patterns act as allelomorphs to each other. (*b*) A fifteenth pattern is "allelomorphic only to its absence."
3. One of the characters of the "multiple allelomorph" group does not always act as an allelomorph to the other members of the group. This is the character I of his first paper, which was noted then for the same behavior. Rather, it behaves (to put it briefly, but in words very different from Nabours's) as if it were closely but not completely linked to the others.

Because I wrote a review of Nabours's first paper on this subject (Dexter, '14), I feel a certain responsibility for what I think are mistaken viewpoints concerning the multiple-allelomorph-nature of this group.